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# Authentic learning supported by technology: 10 suggestions and cases of integration in classrooms

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# Authentic learning supported by technology: 10 suggestions and cases of integration in classrooms

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## Abstract:

Technology use in classrooms is often employed for all the wrong reasons—such as convenience, pressure from school administrators, the belief that students need to be entertained, and so on. In this paper, we argue that technology presents the opportunity to employ powerful cognitive tools that can be used by students to solve complex and authentic problems. In order for this to occur, however, technology needs to be used in theoretically sound ways, and it needs to be used by students rather than teachers. We present ten practical ways for technology to be used effectively and meaningfully in school classrooms that are based on principles of authentic learning.

## Introduction

Many classroom teachers are seeking more interesting ways to use technology in their classes, not only as a means to engage students in meaningful and immersive learning environments, but also to enable students to use and experience powerful cognitive tools. However, what often happens when teachers begin to expand their use of technology is that the teacher is the only one to use the technology, usually in the form of exposition of content, such as in PowerPoint presentations or showing documentaries or films. Or alternatively, the focus sometimes rests solely on the technology itself, such as in learning to use a digital video camera, rather than on the knowledge, content and processes of the subject area. However, as noted by Churchill (2005) 'technology amplifies our intellectual and physical capacity' (p. 347), and in this context, technology can play an integral role in supporting higher order learning.

Jonassen has argued that computer technologies, when used as *cognitive tools* or *mindtools*, represent a departure from traditional thinking about technologies (Jonassen, 2000; Jonassen & Reeves, 1996). Rather than be used as a means to efficiently transmit information and content to learners, technologies can be used by students as 'intellectual partners', and as tools to analyze and interpret their understanding. Critically, Jonassen (1994) contended: 'Students cannot use [cognitive] tools without thinking deeply about the content that they are learning, and second, if they choose to use these tools to help them learn, the tools will facilitate the learning process'.

In this paper, we describe ten ways to incorporate technology into your classroom teaching that endeavour to put the technology in the hands of the students so that it becomes a key factor in the learning process, and a critical element in the learning partnerships developed. The approach is based on principles of authentic learning (described in detail in Herrington & Herrington, 2006; Herrington & Oliver, 2000).

## Authentic learning in nature

In a paper published in the journal *Science* in 2006, Thornton and McAuliffe investigated if and how teaching occurs in the wild, noting that there is only equivocal evidence of teaching behaviour in any species other than humans. They observed that wild meerkats in South Africa taught their young to collect and eat prey safely (Thornton & McAuliffe, 2006). In an interview with the BBC *Science in Action* program, Thornton said that older meerkats:

> … gradually introduce pups to live prey. So when pups are very little they get brought dead prey, like scorpions, lizards, and spiders; as they start to get older, helpers will bring them prey that's been disabled, so if it's a scorpion the helper might bite the sting off before giving it to the pup. Then finally when the pups are approaching independence, the adults will give them live food that the pups have to deal with on their own (BBC News, 2006, pp. 1-2).

The study received much publicity in the media when it was first published, with many commentators observing that the meerkats teach their young just like humans do. But is that how we teach our young? Or is the traditional model of education one that prevails, where students are seated in rows at their desks facing the teacher at the front of the class and they are taught in a largely didactic and decontextualised manner. The learning environment described in the meerkat research is perhaps more akin to the apprenticeship model that has recently been examined in more depth in relation to situated learning theory.

In 1987, Resnick (1987) proposed that 'bridging apprenticeships' be designed to bridge the gap between the theoretical learning in the formal instruction of the classroom and the real-life application of the knowledge in the work environment. Later, Brown, Collins and Duguid (1989) wrote that a means of achieving this, was to use a model of *cognitive apprenticeship*, a method designed to 'enculturate students into authentic practices through activity and social interaction' (p. 37), based on the successful and traditional apprenticeship model. In an elaboration of the cognitive apprenticeship model, Collins, Brown and Newman (1989) contended that traditional apprenticeships have three characteristics that are cognitively important:

1. Learners have continual access to models of expertise-in-use against which to refine their understanding of complex skills.

2. Apprentices often have several masters and have access to a variety of models of expertise leading to an understanding that there may be different ways to carry out a task, and that no one individual embodies all knowledge and expertise.

3. Learners have the opportunity to observe other learners with varying degrees of skill. (p. 456)

## What are the characteristics of authentic learning environments?

From this work in the late 1980s and since, a critical reading of the principal theorists of cognitive apprenticeship and situated learning reveals a number of important characteristics which have added to the evolving theory of authentic learning (Herrington & Oliver, 2000, p. 26). Many of these authors believe that useable knowledge is best gained in learning environments that feature the following characteristics. The learning environments should:

- Provide authentic context that reflect the way the knowledge will be used in real-life (e.g., Brown, Collins, & Duguid, 1989; Collins, 1988; Gulikers, Bastiaens, & Martens, 2005)
- Provide authentic activities (e.g., Brown, Collins, & Duguid, 1989; Cognition and Technology Group at Vanderbilt, 1990; Jonassen, 1991; Young, 1993)
- Provide access to expert performances and the modelling of processes (e.g., Collins, Brown, & Newman, 1989; Lave & Wenger, 1991)
- Provide multiple roles and perspectives (e.g., Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990; Honebein, Duffy, & Fishman, 1993; Lave & Wenger, 1991; Spiro, Feltovich, Jacobson, & Coulson, 1991)
- Support collaborative construction of knowledge (e.g., Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990; Brown, Collins, & Duguid, 1989)
- Promote reflection to enable abstractions to be formed (e.g., Boud, Keogh, & Walker, 1985; Norman, 1993)
- Promote articulation to enable tacit knowledge to be made explicit (e.g., Lave & Wenger, 1991; Pea, 1991; Vygotsky, 1978)
- Provide coaching by the teacher at critical times, and scaffolding and fading of teacher support (e.g., Collins, 1988; Collins, Brown, & Newman, 1989; Greenfield, 1984; Harley, 1993)
- Provide for authentic, integrated assessment of learning within the tasks (e.g., Gulikers, Bastiaens, & Kirschner, 2004; Herrington & Herrington, 1998; McLellan, 1993; Reeves & Okey, 1996; Young, 1993, 1995).

## Using principles of authentic learning with technology

Using principles such as these to design learning tasks in classroom contexts can provide a learning environment that is not only innovative and rewarding for both students and teacher, but is also theoretically sound. Using technology to implement or enhance such principles further increases their appeal to students, but also provides powerful tools to assist their learning. While not crucial, there is little doubt that different forms of technology afford great potential as enablers for each of the nine authentic principles listed above.

In the next section, each principle is described in brief and examples from a range of classroom contexts are given of how it can be employed with thoughtful and creative use of readily available technologies. While just one principle is the focus of each of the sections, ideally any learning environment should consider all aspects in its design to ensure maximum effect. These principles form the basis of nine of the ten suggestions in this paper for transforming your ideas about authentic learning into classroom practice using technology. The last suggestion is an overall one that is critical to any teacher's professional practice but one that itself can also be facilitated by technology: ongoing professional learning and development.

### *1. Authentic context*

Authentic contexts in the classroom are more than simple examples from real world practice that act as illustrations of a concept being taught. The context needs to be all-embracing, to provide the purpose and motivation for learning, and to provide a sustained and complex learning environment that can be explored at length. It needs to reflect the way the knowledge will ultimately be used, so it presents the whole environment first, rather than introduce elements one by one. Through the use of technology, it is possible to bring a range of authentic contexts into the classroom.

**Example: *Sydney Olympic Park project***

Technology tool: Web resources and excursion
Target students: Year 10
Subject area: Geography

While perhaps best known as the site of the 2000 Olympic Games, the Sydney Olympic Park is also important for its biodiversity and resource conservation. Its school education program incorporates an authentic context for the study of Year 10 geography. In a learning challenge designed to enable students to learn key geography skills (described in detail in Brickell & Herrington, 2006), an authentic context is provided in the form of a brief animation (Figure 1). The park is experiencing problems with mosquitos, smelly ponds and rats attracted by food scraps and other rubbish left by visitors. The administrators of the park are concerned and write a letter to call for the help of 'experts'—the geography students. They are required to investigate the problem

(which they do on an excursion to the park and research conducted before and after the visit), and to present a report to the park authorities.

**Figure 1:** Mosquitoes in the park, the administrators are concerned, letter to experts

Using technology to access authentic context s such as these means that a whole learning scenario can be presented in realistic and motivating ways using images, animations and sound. But it also means that technology enables the use of tools—without which students would have difficulty engaging conceptually with the material.

### *2. Authentic activities*

Authentic activities or tasks reflect the kind of activities that people do in the real world, that are completed over a sustained period of time, rather than a series of shorter disconnected examples. They are generally ill-defined, that is students *find* as well as *solve* the problems. Many classroom activities are so structured, they fail to account for the nature of real-world problem solving. An authentic approach would have learners exploring a resource with all the complexity and uncertainty of the real world. The learners would have a role in determining the task and how it might be broken up into smaller tasks, selecting which information is relevant, and finding a solution that suits their needs. Many project-based assignments in school readily provide such opportunities, especially when they allow the use of powerful technologies.

**Example**: *Plan a trip to Australia*

Technology tool: Online discussion forums/email
Target students: Upper primary
Subject area: English language

Students learning English could use discussion forums and chat spaces to converse in English with students in a school in Australia. Connecting with a similar grade level at an overseas school, if it can be arranged, is an excellent way to learn and consolidate language skills, as well as a means to learn about another culture (Pais-Marden, 2007). An authentic context, such as planning a five day trip to the foreign country enables students to focus on a real goal, and to ask genuine questions about sights to see, food, transport, currency and customs and lifestyles. They can then use other sources to research their trip and plan an itinerary.

Opportunities can also be taken to involve students in advertised competitions and other schemes such as *GetReel*, a joint initiative of Youth Off The Streets and the Sony Foundation Australia, where students aged between ten and sixteen years are invited annually to 'design a 30 second television ad targeting youth drug use and it could be shown on National TV' (www.youthoffthestreets.com.au/getreel). In this example, the use of technology to plan, create and edit a multimodal text provides for an authentic activity that would simply not be possible through more traditional resources and classroom experiences.

### *3. Expert performance*

People sometimes comment that it is much easier to learn a skill or concept when they see it demonstrated by an expert. Authentic learning environments provide access to such expert thinking and performances, allowing students to observe the task before it is attempted and to access the modelling of processes. This characteristic draws largely from the apprenticeship system, where a learner is assigned to work with an experienced practitioner. Technology allows for the incorporation of a range of 'experts' within the classroom environment in ways that are accessible, cost effective and appropriate for the experience.

**Example**: *ClassSim: Learning to think like a teacher*

| | |
|---|---|
| Technology tool: | An online simulated environment |
| Target students: | Pre-service teachers |
| Subject area: | The work of a teacher |

Understanding the intricacies of a classroom environment is a challenge faced by many pre-service teachers. *ClassSim* is an online, simulated environment developed to enable pre-service teachers to assume the role of a virtual teacher as they make decisions about teaching and learning experiences, classroom organisation and responses to individual students (described in detail in Ferry, Kervin, Cambourne, Turbill, Hedberg & Jonassen, 2005). Whilst a simulation is only a representation of real-life, there are features that can enhance real-life experiences. For example, a simulation can provide authentic and relevant scenarios, make use of pressure situations that tap users' emotions and force them to act, they can provide a sense of unrestricted options with the ability to carefully review the consequences of decisions made. The opportunity to work within this virtual environment enables pre-service teachers to explore the various aspects of classroom life, with the opportunity to pause or repeat key parts, to explore alternative decisions and create other classroom worlds with the support of feedback and advice embedded within the software.

**Example**: *Capturing explicit processes through vodcasts and podcasts*

| | |
|---|---|
| Technology tool: | Digital camera, iPods with voice recorders, class web environment and classroom experiences |
| Target students: | Year 4 |
| Subject area: | Emphasis on Mathematics and English curriculum areas |

There are explicit processes that students need to understand within many curriculum areas; the learning of the process for long division and understanding grammatical patterns and conventions are examples. To meet this need, a classroom teacher facilitated opportunity where explicit teaching experiences could be recorded as either a vodcast or podcast, uploaded to a web environment, to be downloaded by students at pertinent times to support their learning both in the classroom and home contexts. While such opportunities may be initially instigated, recorded and made available by the teacher, students too can become involved in the creation of these resources for themselves and their peers (such as in Figure 2). The developed files provide students with access to expert thinking and performances with opportunity to listen and view footage as specific processes are modelled.

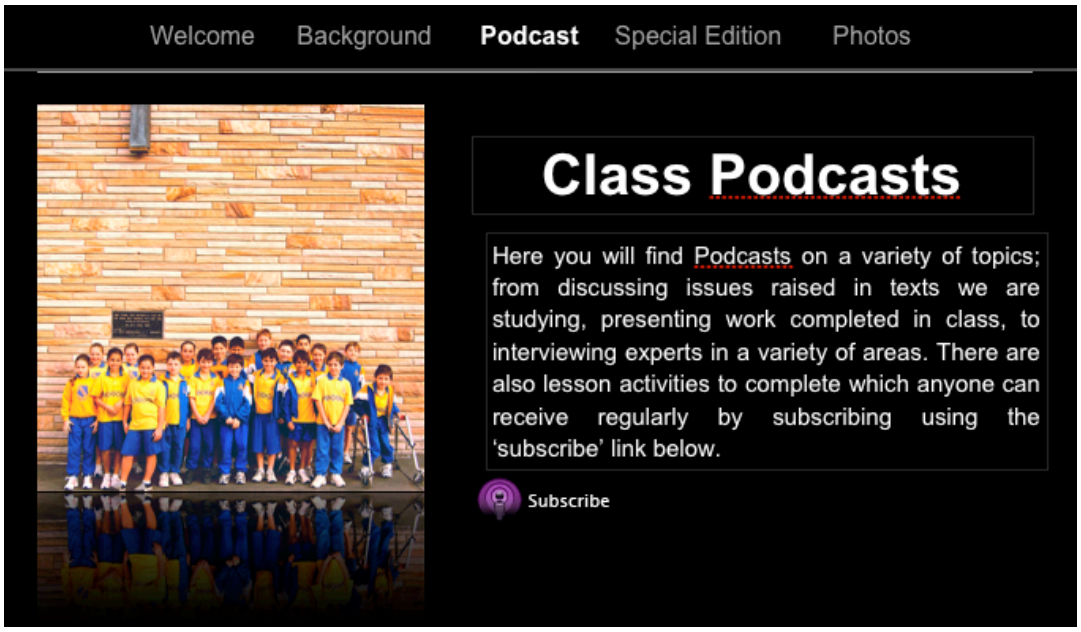


**Figure 2:** Introduction screen to student podcasts

These environments illustrate the opportunities technology affords in accessing expert thinking in a manner that would be difficult or impossible to achieve without it. In placing the tools in the hands of the student, so that they are not only consumers but also producers of the resources, they are thinking deeply about the subject and engaging at a level that goes beyond the visiting class speaker.

### *4. Multiple roles and perspectives*

Rather than learn through interaction with a single perspective (the teacher's), an authentic learning environment provides the learner with the opportunity to investigate multiple ideas, roles and perspectives. Different people, media and resources are employed as required to provide a rich array of opinions and points of view. Technology allows for this range to be brought into the classroom. However, it is vital

that students are supported in the management of these as they discriminate and discern amongst sources.

**Example**: *Planning an investigation*

Technology tool: Microsoft Word
Target students: Middle–upper primary
Subject area: Cross-curricula

When conducting research, it is important that students understand the need to draw on and discriminate among multiple sources as they prepare their response to the task. Engaging in a planning experience where students nominate from the range of sources available to them, and consider which would be most appropriate to use, provides them with a framework to investigate some of the multiple ideas and perspectives surrounding the particular focus. Providing a proforma that can be completed electronically, allows students to engage in initial planning, but also the ability to update this easily throughout the learning process (see Figure 3). Gathering information from multiple sources further supports the notion of research as a way to inform their understandings.

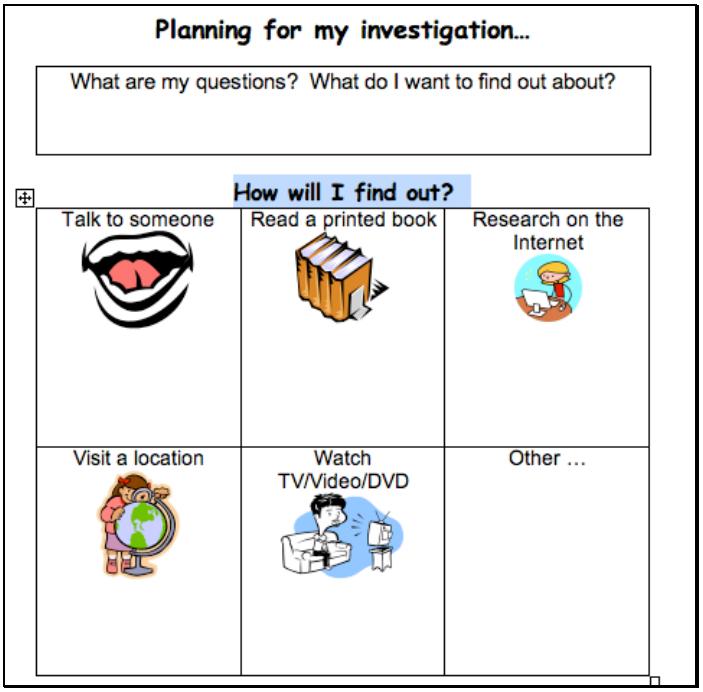


**Figure 3:** Planning sheet for students to nominate a range of resources

The use of word processing software as an organizational tool allows students to plan an activity or task in depth but also to reflect upon the nature of sources of information and the strengths of each particular medium, and the value of the particular source.

### *5. Reflection*

Many learning opportunities in school are wasted when students are not given an opportunity to reflect upon and consolidate their learning. This is typified in anecdotes of students study, knowing that they only need to remember the information long enough to complete the test, then they can forget it and move on to the next topic. Boud, Keogh, and Walker (1985) contended that reflection is a social process, not necessarily a quiet, solitary activity. An authentic learning environment requires students to reflect upon a broad base of knowledge to solve problems, and to predict, hypothesise, and experiment to produce a solution.

**Example**: *Learning journal*

Technology tool: Web log site or word processing
Target students: All
Subject area: Multi-disciplinary

Online journals and blogs, or more simple and available tools such as word processing software, provide excellent opportunities for students to reflect on their learning journey, either individually or collaboratively. While completing a complex learning task, a journal can be kept (for example, in Microsoft *Word*, Notebook view) to illustrate processes, problems, conversations, resources, examples, and ideas. The journey can be presented in words, pictures, graphics, sounds, movies and other media, and after editing, it can be packaged as a product for inclusion in a student's portfolio.

The use of technology allows for students to record their learning and subsequent reflections in ways that are easily updated, retrieved, shared, and stored—factors that contribute to the creation of products that would be difficult or impossible to achieve using pencil and paper resources alone.

### *6. Collaboration*

Many classroom tasks are designed for the individual learner. However, there is much research (see Del Marie Rysavy & Sales, 1991) to show that there are clear educational advantages to be derived from collaboration between students who are required to solve problems. Authentic learning environments allow opportunities for much of the time for students to work in small groups or pairs. Such an arrangement allows students to 'put their heads together' on problems, and to fully articulate their progress as they go about the task.

**Example:** *Create an interactive presentation*

Technology tool: PowerPoint, search engines, digital camera
Target students: Lower primary
Subject area: Writing, and Human Society and its Environment (Social Studies)

Working as a collaborative group of six, lower primary students jointly selected a topic for investigation. To begin, they identify specific questions they want to find out about

and create a plan for a non-linear text representative of each of these areas for investigations. In this example, the students were encouraged to think of a webpage as an example of a non-linear design. Working individually, in partners, or as a whole group students conduct research, collect photographs, survey classmates and interview appropriate people to compile the information needed to respond to their questions. As written texts are developed they are peer-conferenced and published onto a PowerPoint slide (Figure 4). Using 'action buttons' within PowerPoint, navigational pathways are created through the texts to support the reader and further the analogy of a webpage.

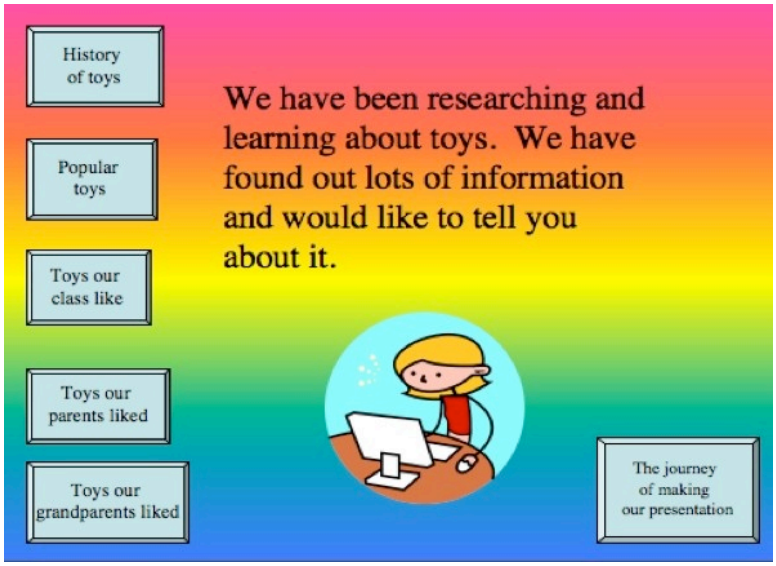


**Figure 4:** Interactive presentation screen in PowerPoint

This process is an example of how a classroom task can encourage a group of students to collaborate as they respond to their research questions and employ technology to represent this in a non-linear format. Learners are able to create their own hypermedia knowledge bases that reflect their collaborative understanding of ideas, knowledge that is 'socially co-constructed' (Jonassen, Carr, & Yueh, 1998).

### *7. Articulation*

Being able to speak the vocabulary and tell the stories of a 'culture of practice' is critical to learning what it means to be a professional (Lave & Wenger, 1991). And yet, many classroom activities are done quietly with no communication allowed with other students. An authentic learning environment would ensure that tasks are completed within a social context—with students working in groups, discussing the issues or processes, presenting talks to class, sharing stories or pictures, interviewing and debating, and so on—to ensure that students have the opportunity to articulate, negotiate and defend their growing understanding. Vygotsky believed that speech is not merely the vehicle for the expression of the learner's beliefs, but that the act of creating the speech profoundly influences the learning process. Vygotsky wrote:

'Thought undergoes many changes as it turns into speech. It does not merely find expression in speech; it finds reality and form' (cited in Lee, 1985, p. 79). This active process is reflected in Mercer's (1996) comment that: 'Talk is now recognised as more than a means for sharing thoughts: it is a social mode of thinking' (p. 374).

**Example**: *Make a movie about something you don't understand*

Technology tool: Digital video camera and iMovie
Target students: Lower secondary
Subject area: Science/Geography

Some television programs delight in revealing the clearly incorrect or incoherent candid camera-type interviews with science graduates, when they have been asked to explain the scientific concepts behind phenomena such as the phases of the moon or the seasons. Using digital video, students can create a film to teach other students a scientific concept—a concept that they have never really understood. In order to explain something to others, students must understand it and be able to articulate the concepts. Similarly, slowmotion animation, or *slowmation* (Hoban, 2005, p. 3) uses 'a simplified version of clay animation' to enhance student understanding. Using the technology of a digital camera, tripod and coloured paper, Kervin (2006) found that Year 4 students could work together in collaborative groups to communicate and justify their understandings to discover a range of ways to represent complex equivalent fractions. The ability for students to control the speed within the slowmation is reported to assist students in developing their understandings, with the recommendation of 2 to 6 frames per second to enhance educational understandings (Hoban & Ferry, 2006).

By focusing on constructing representations of knowledge, this learning environment resonates with the theory of *constructionism* espoused by Seymour Papert (1991). The exploration, construction and articulation of powerful ideas are at the heart of the theory, and student engagement with visually representing and articulating understanding of a scientific concept is an excellent example of technology as cognitive tools.

### *8. Coaching and scaffolding*

In an authentic learning environment, the role of the teacher is one of coaching and scaffolding—observing students, modelling, providing resources, offering hints and reminders, providing feedback, and so on—rather than a didactic one. In this role, the teacher provides the skills, strategies and links that the students are unable to provide themselves to complete the task. When appropriate, the support (the scaffolding) is removed until the student is able to 'stand alone'. Coaching is highly situation-specific and is related to problems that arise as students attempt to integrate skills and knowledge (Collins et al., 1989). Such assistance can also be provided by other students, and collaborative learning can ensure that more able students can assist their less able partners (Collins, et al., 1989; Greenfield, 1984).

**Example**: *Scaffolding writing through a virtual conference*

Technology tool: Tracking mode in Microsoft Word
Target students: Lower primary
Subject area: Writing

Students frequently create written text using word processing software in their classrooms. Using the affordances of software such as Microsoft Word provides for a myriad of possibilities for scaffolding specific writing focused knowledge and skills. For example, a class of lower primary students independently created a piece of writing in Word. The teacher, using the tracking tool embedded within the software, then reviewed these writing samples providing a written commentary for each individual student (see example in Figure 5).

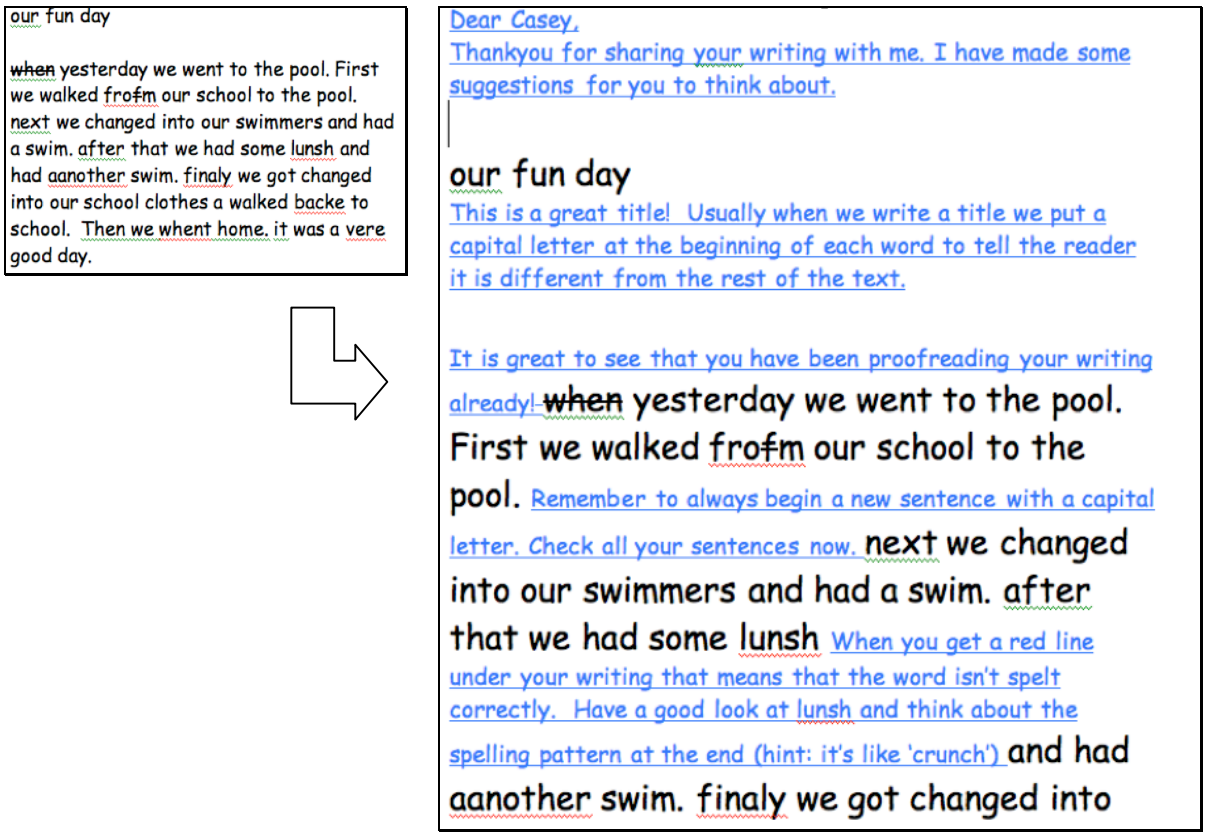


**Figure 5:** Original passage of student writing (left) and passage annotated by teacher in tracking mode (right)

This activity has provided a seamless and effective avenue for teacher feedback on what the student had done well in the text, but also allowed for the identification of areas for improvement.

### *9. Integrated authentic assessment*

When a topic is complete, students are often assessed with separate tests or quizzes. While institutional and course demands often limit teachers' discretion on testing, where possible, in an authentic learning environment, assessment should be seamlessly integrated with the activity, that is, students are assessed on the task they perform rather than with a separate test. Assessment of authentic learning can take the form of a number of evaluation measures which do not include formal tests, such as portfolios, journals, and self-assessment (McLellan, 1996) and it creates opportunities to enable students to craft polished performances.

**Example**: *Create an online portfolio*

| | |
|---|---|
| Technology tool: | Online portfolio |
| Target students: | Upper primary, secondary |
| Subject area: | Multi-disciplinary |

Online portfolios allow students to create products for assessment and to present them as polished and refined accomplishments rather than first drafts of work. For example, rather than submit paper versions of projects and assignments, students can use iWeb (free software provided with the Macintosh operating system) or other web publishing software to readily create an online portfolio to organize their work. Students can upload a range of resources including video, sound, music, writing, dialogue, compositions and images.

When portfolios are used for assessment in this manner, they demonstrate many criteria of higher order thinking, such as those described by Kendle and Northcote (2001) in their model of authentic online assessment, such as: [the portfolio] demonstrates a clear purpose and outcome, models an authentic situation, emphasises process over product, gives students choices, encourages the appropriate, discriminatory use of online resources, and enables students to examine and present many viewpoints (p. 921). Other critical factors that come into play when students create portfolios for assessment include the opportunity to be effective performers with acquired knowledge (rather than the reproduction of information in tests), and to craft polished, performances or products (rather than first drafts, or incomplete and inadequate work) (Wiggins, 1993; Reeves & Okey, 1996; Herrington & Herrington, 1998).

## Last but not least

This paper promised ten ways to transform ideas about authentic learning into classroom practice using technology, and while nine of these methods are theoretically based in principles of authentic learning, the last is universally regarded as essential in teachers' professional practice. The last item concerns professional learning and development, and keeping informed about new technology developments in pedagogy.

### *10. Professional learning*

Professional learning is crucial in a time of rapidly changing technology and concomitant pedagogy. It is important to keep up with both technology and its applications in classrooms. However, many argue that training in technology and pedagogy alone is not the answer. Schlager and Fusco (2003) argued:

> Training (and technology that supports a training model of learning) tends to pull professionals away from their practice, focusing on information about a practice rather than on how to put that knowledge into practice. Only by engaging in work and talking about the work from inside the practice can one learn to be a competent practitioner. (p. 203)

Establishing communities of practice for teachers is a means of maintaining professional learning and development in a supportive and meaningful context that relates directly to the day-to-day work of teachers.

**Example**: *An online community of practice for beginning teachers: The BEST site*

| | |
|---|---|
| Technology tool: | Website |
| Target participants: | Beginning teachers |
| Subject area: | Professional learning of teachers |

An online community of practice called the 'BEST' site: *Beginning and Establishing Successful Teachers* (described in detail in Herrington, Herrington, Kervin, & Ferry, 2006) has been established for primary and early childhood teachers. The site is organised around significant problem-based issues identified by beginning teachers, with tools that enable support, communication and reflection. Beginning teachers can keep in touch with other teachers from their year at university, and share stories and ideas about their teaching. They can access up-to-date resources through live RSS feeds from EdNA Online (Education Network Australia) on a range of curriculum areas. Importantly, they can access the wisdom and experience of online mentors, all of whom are 'Highly exemplary teacher' awardees (awarded by the Australian College of Educators). Teachers can ask questions (anonymously if they choose) and mentors provide guidance and advice online through issues-related discussion boards (e.g., see Figure 6 for an example of an anonymous question answered by a mentor). There is also a chat space and web logs written by first year teachers on their experiences.


**Figure 6:** Question and answer on classroom management on the BEST site

While Schwen and Hara (2003) have cautioned against the tendency to romanticize the construct of communities of practice, especially online communities, they acknowledged their usefulness for professional development if a community is strong and comprises motivated members rather than unwilling participants. Online communities are particularly useful when teachers face physical or professional isolation.

## Using principles of authentic learning in the design of learning environments

Teachers wishing to employ more authentic approaches in the classroom can use the principles described here to assist in their thinking, planning and implementation of the learning design. For example, if you wish to create a project that might incorporate a range of mathematics, science and language skills, it is helpful to list the knowledge and skills that you would like the students to learn. You can then think about how this knowledge might be applied in real world applications to help you create an *authentic context* and *authentic tasks*. It is then useful to ask yourself a series of questions, such as: How can I ensure students have access to *expert opinion*? To *multiple perspectives*? What opportunities will students have to *collaborate*? To *reflect* on their learning? To *articulate* and discuss their growing understanding? How can I support students through

*scaffolding* and guidance rather than by direct exposition? How can I ensure *assessment* is authentic and integrated with the task?

Lastly, question yourself about your own ongoing opportunities for *professional learning* so that you can keep abreast of new pedagogical strategies and approaches, and advances in technology. In this way, you will be giving your students opportunities to learn in innovative, challenging and creative ways, using technology as a tool rather than as a one-way source of information.

## Conclusion

Many authors and teacher educators have explored the introduction and use of information and communication technologies in the school classroom from a variety of international perspectives (Baskin & Williams, 2006; Kangro & Kangro, 2004; Lim et al., 2003; Misra, 2006; Vavouraki, 2004). What is clear from this body of work is that technologies cannot be introduced in an ad hoc or top-down manner. Nor should there be an emphasis on the technology itself promoting physical engagement at the expense of cognitive engagement (Foo, Ho, & Hedberg, 2005).

In this paper, we have focused on the use of technology as cognitive tools within authentic learning environments—exactly the kind of environment envisaged by Jonassen and Reeves (1996) who believed 'the enormous potential of cognitive tools can only be realized within a constructivist framework for learning' (p. 699). Jonassen (1994) described cognitive tools as 'a set of tools that learners need in order to serve cognitive apprenticeships'. When technology is used as cognitive tools rather than for the dissemination of content and information, it allows students to engage more meaningfully with tasks, and 'to assume ownership of their knowledge, rather than reproducing the teacher's' (Jonassen, 1994).

The practical ways we identify for technology to be incorporated within classrooms, highlight the importance of identifying clear purpose and rationale for its inclusion within learning experiences. Experiences that put technology into the hands of the students challenge the traditional roles of teachers and students and their associated relationships. It is the teacher's responsibility to ensure that technology experiences are closely associated with the rationale and purpose of an authentic learning experience. Each of these examples highlights the importance of the teacher and students having a clear rationale for completing the task, understanding of the real-life application of the task and appropriate support to complete the task. Technology affords students the opportunity to engage with tasks that could not be completed using traditional paper-based methods.

While authentic learning environments are intuitively appealing, much research needs to be conducted on how best to use them in classrooms. Proving whether authentic approaches work better than other methods by conducting empirical, quantitative

research studies is arguably unnecessary and premature. As argued by Reeves (1999), the most important emphasis now for educational technology research should be on how to *improve* learning outcomes, not to *prove* that one method works better than another:

> As we enter the new millennium, I maintain that our research and evaluation efforts should be primarily developmental in nature, that is, focused on the invention and improvement of creative approaches to enhancing human communication, learning, and performance through the use of interactive learning technologies. The purpose of such inquiry should be to improve, not to prove. (p. 18)

Reeves (1999; 2000) has called for more socially responsible research that focuses on development goals, such as design-based research (also known as *development research* or *design experiments*) (Brown, 1992). Research on authentic learning environments using technology complement this approach, because of its emphasis on solving real-world educational problems and the design of an intervention which is often technology-based. The production of guidelines for other practitioners to use to address similar problems is a useful outcome of this type of research.

Focusing on authentic contexts and tasks and the conditions that enable them is a useful reference point for the effective use of technologies as mediating tools to support student learning. Such technology use has the potential to transform and enrich learning experiences. However, for this to happen it is imperative for teachers to carefully plan for and facilitate classroom tasks that promote the principles of authentic learning. Technology must be used in a way that is both authentic and pedagogically appropriate for the experience, so that students can engage in cognitive apprenticeships; in this paper, we have given ten practical strategies for accomplishing this.

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